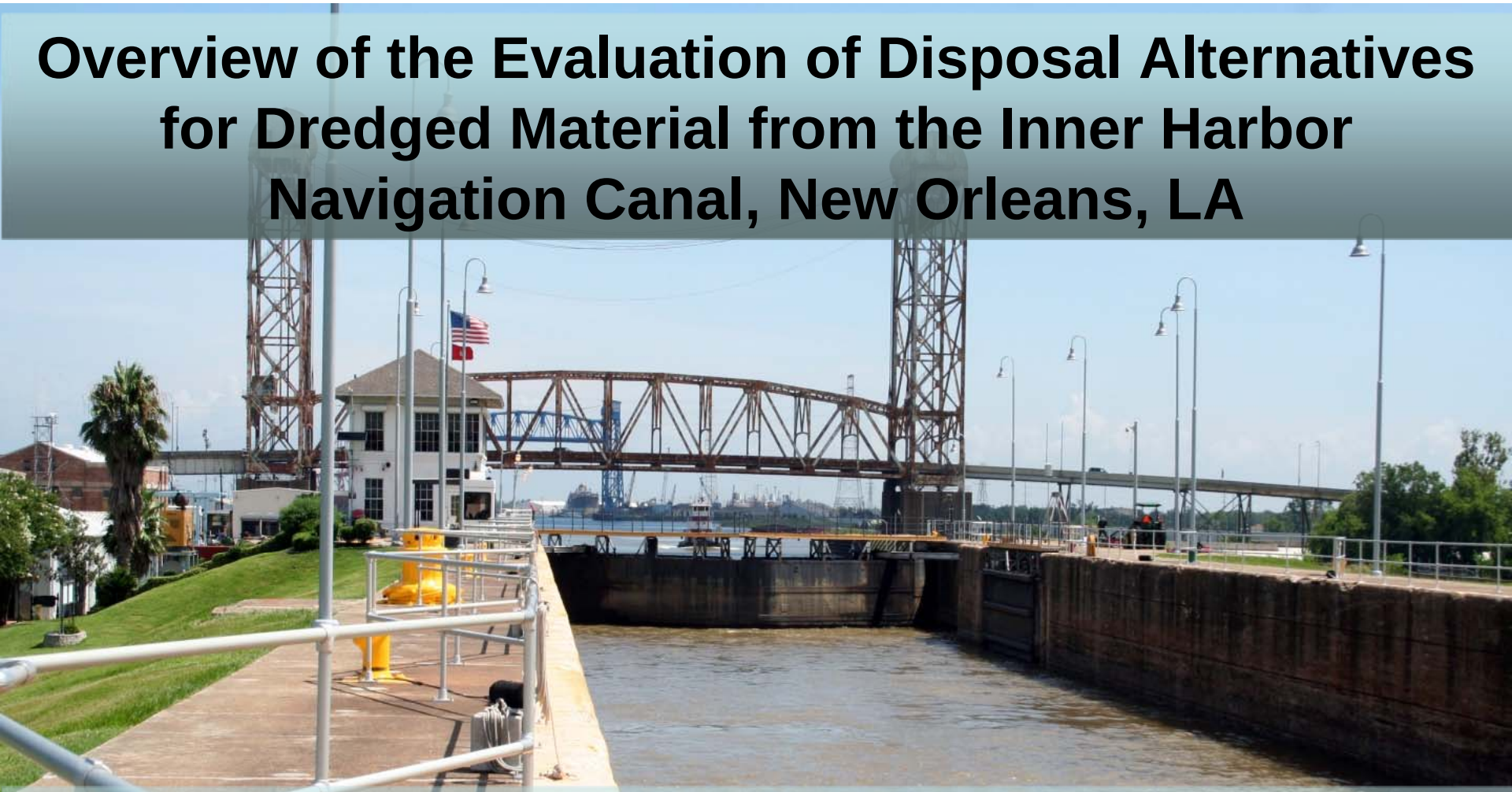
Overview of the Evaluation of Disposal Alternatives for Dredged Material from the Inner Harbor Navigation Canal, New Orleans, LA



Guilherme Lotufo, Jeff Steevens, Richard Price, Alan Kennedy, John Farrar, David Johnson, Trudy Estes, Paul Schroeder

US Army Engineer Research and Development Center

Jeff Corbino, Eric Glisch

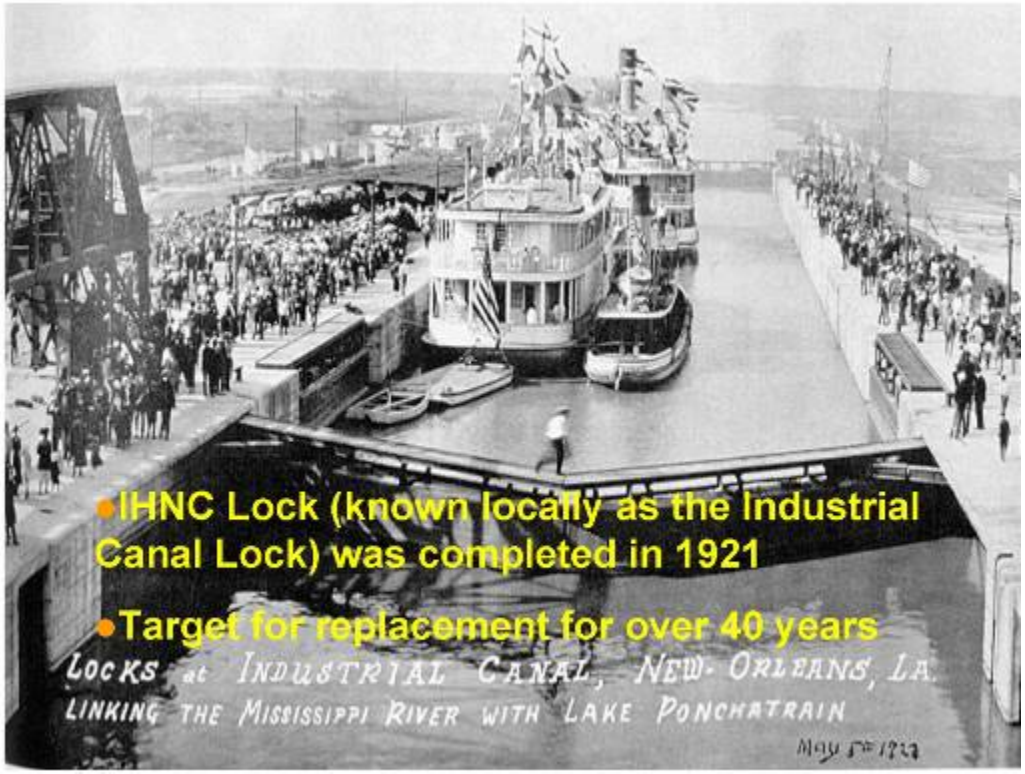
US Army Corps of Engineers, New Orleans District

David Moore, Wendy Hovel

Weston Solutions

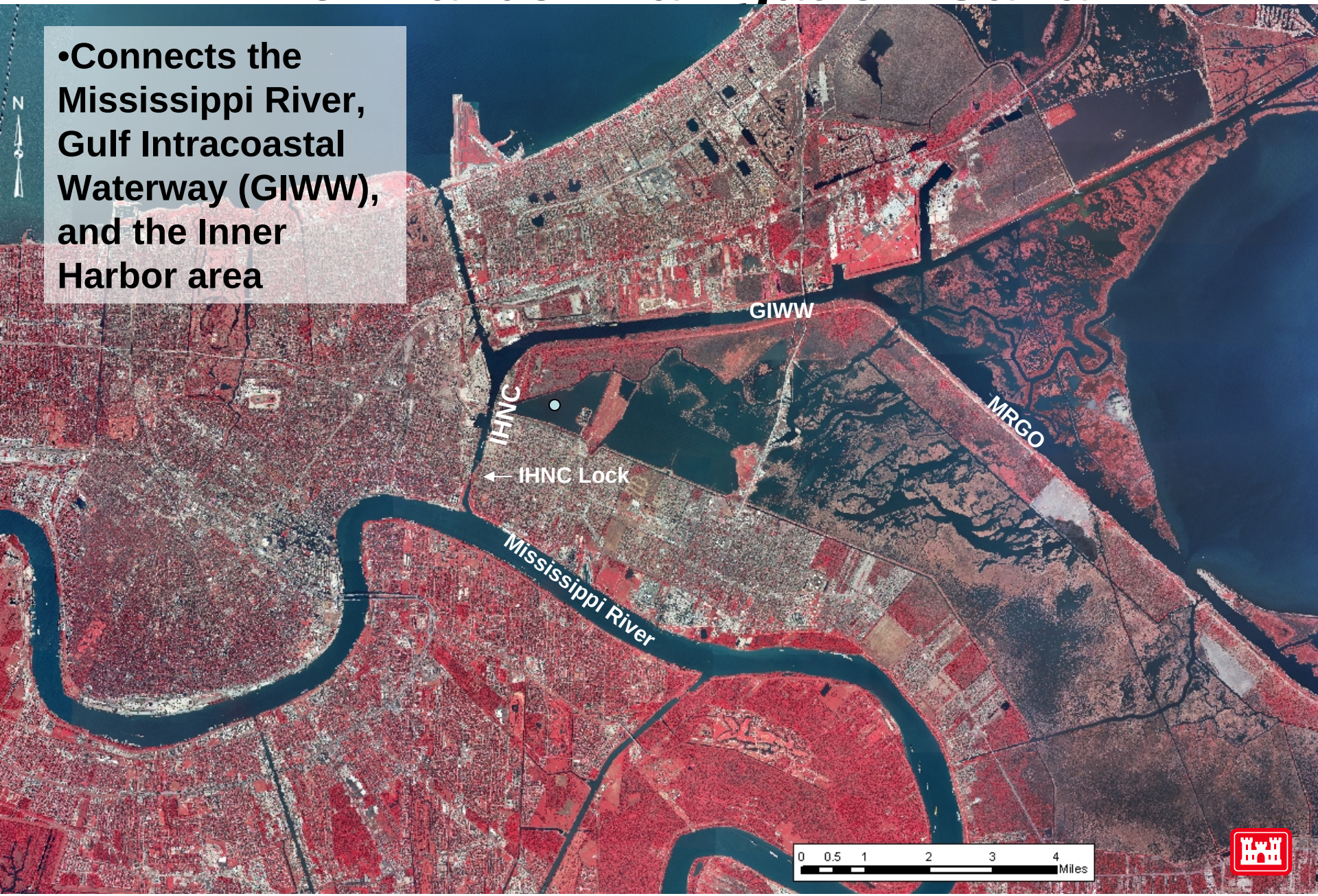
IHNC Background

- Lock and channel constructed in 1921
- Current lock is too small to accommodate existing traffic
- Target for replacement for over 40 years
- Sediment contamination due to industrial activity

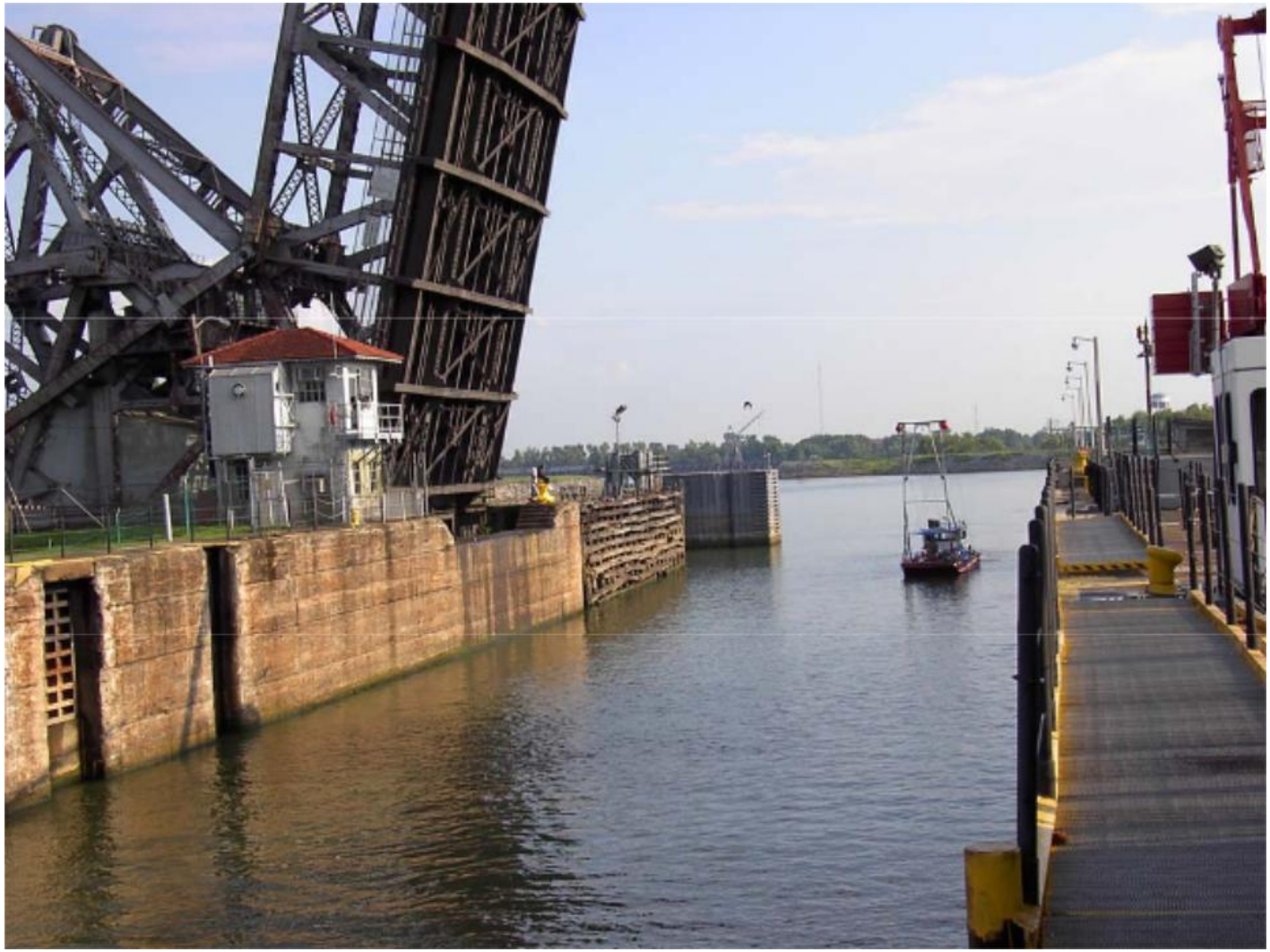


- Sediment and soil proposed for dredging (1.5 M cy) requires evaluation under Clean Water Act

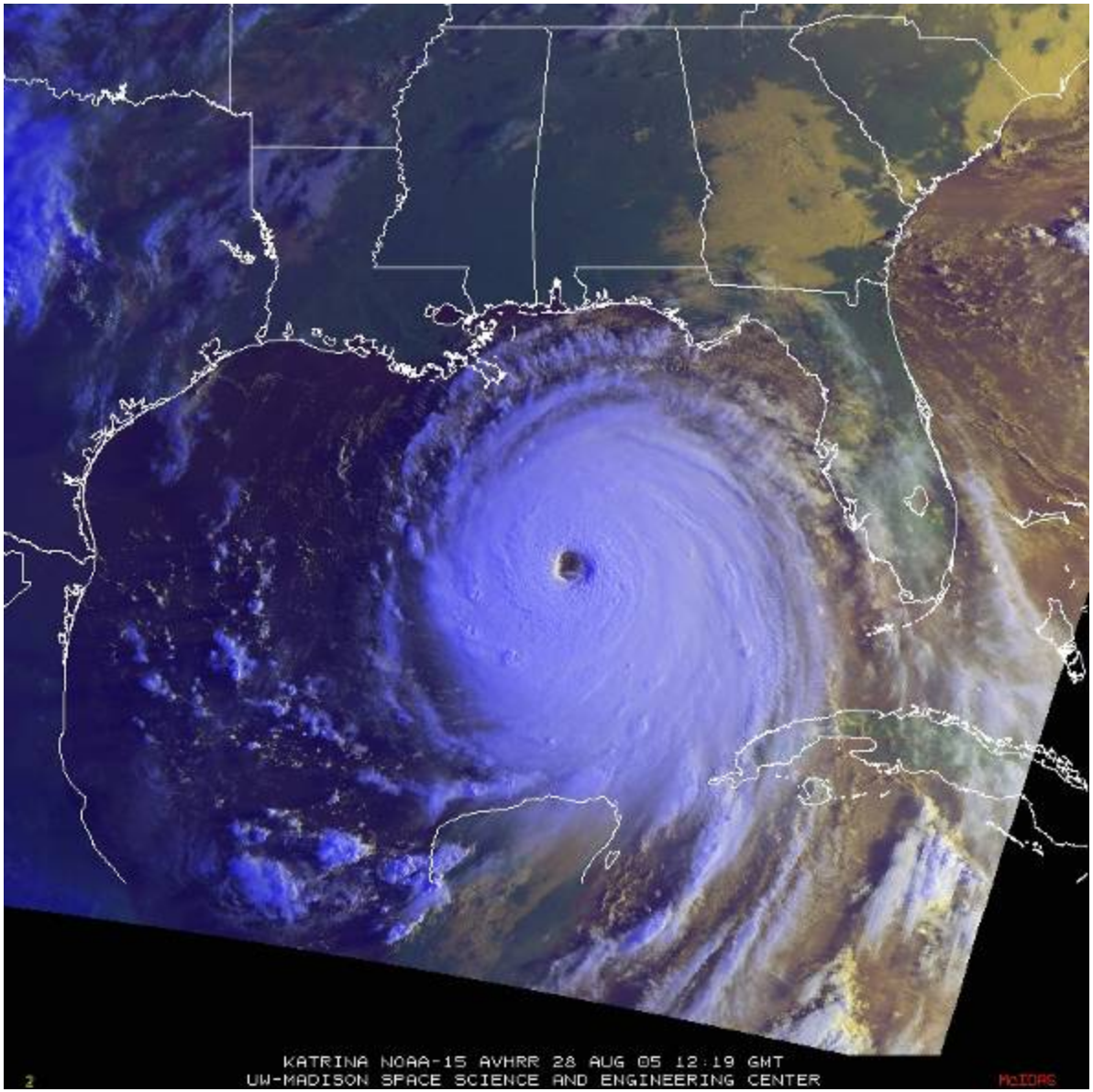
Inner Harbor Navigation Canal



IHNC Sampling in 2005



28 August 2005

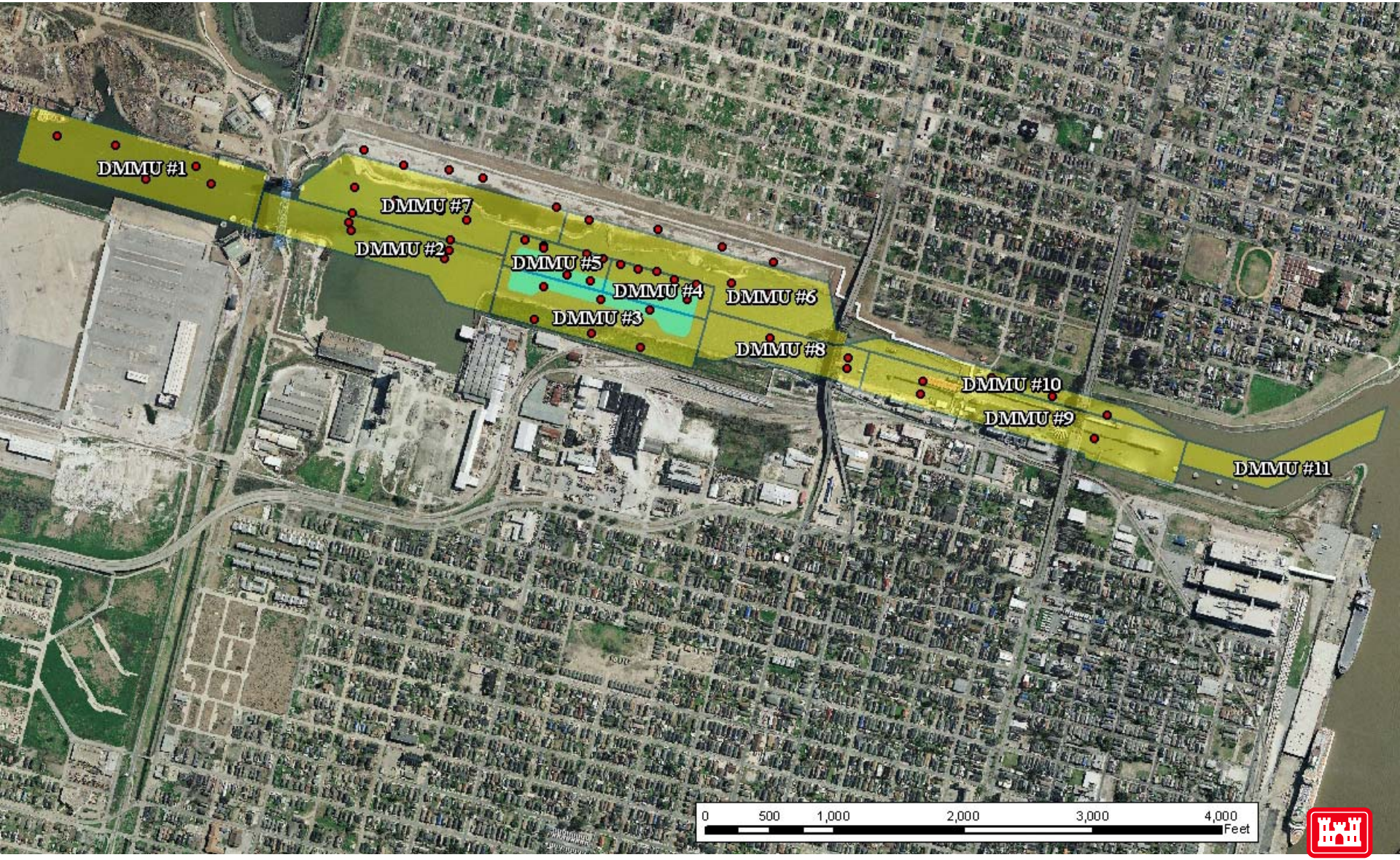


30 August 05

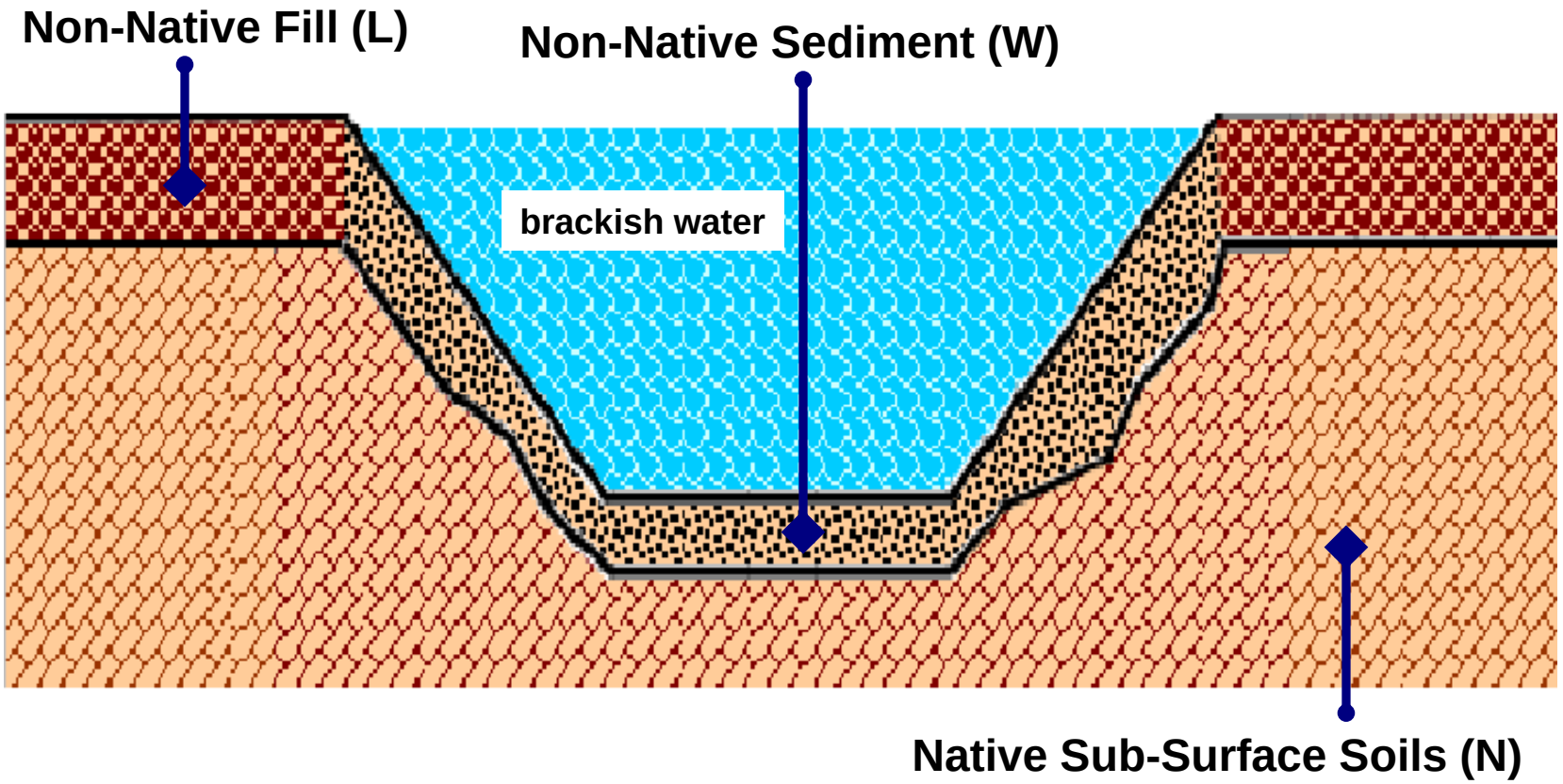
30 August 05

IHNC Neighbors Not Happy...

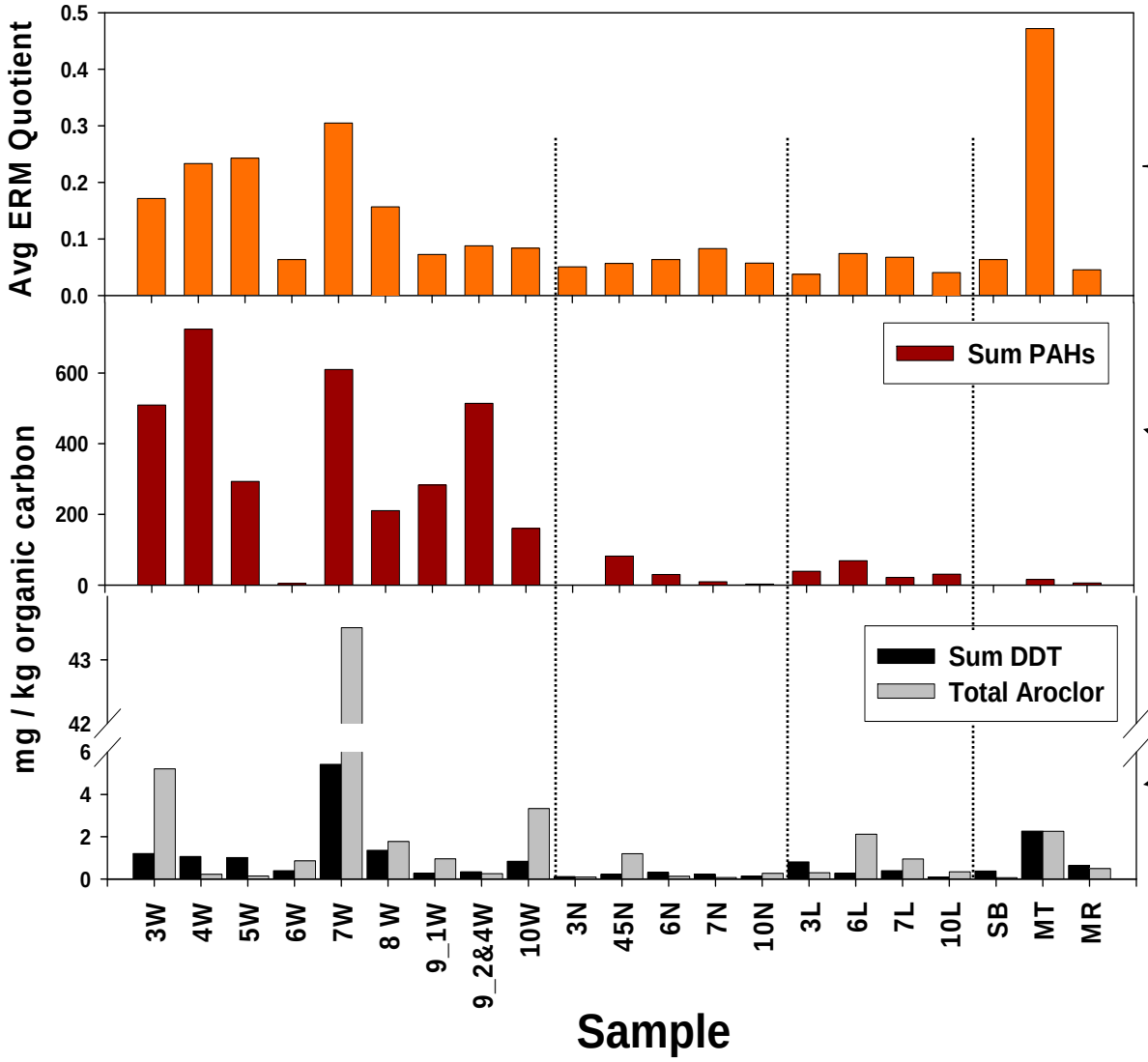
Dredged Material Sampling



Vertical Sub-Division of Sediments and Soils



Sediment Chemistry – Overall Trends



$$ERM_Q = \frac{\text{Concentration}}{\text{ERM}}$$

Average ERM_Q for: Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Silver, & Zinc

Sum PAH, Sum DDT, & Total Aroclors

W - Surface sediments
L – Fill material from banks
N – Native subsurface soils
SB – Estuarine reference site
MT – Estuarine disposal site
MR – Mississippi River reference

Governing Framework for Environmental Evaluations

- Regulatory
  - Clean Water Act (CWA)
- Technical
  - USACE/EPA Technical Framework
  - Inland Testing Manual (ITM)
  - Upland Testing Manual (UTM)

Dredged Material Testing and Evaluation

FRESHWATER – Mississippi River Disposal Site
ESTUARINE – Beneficial use for marsh creation
TERRESTRIAL – Upland Disposal

Water column evaluation

Elutriate toxicity

Mixing zone modeling – comparison with Water Quality Standards

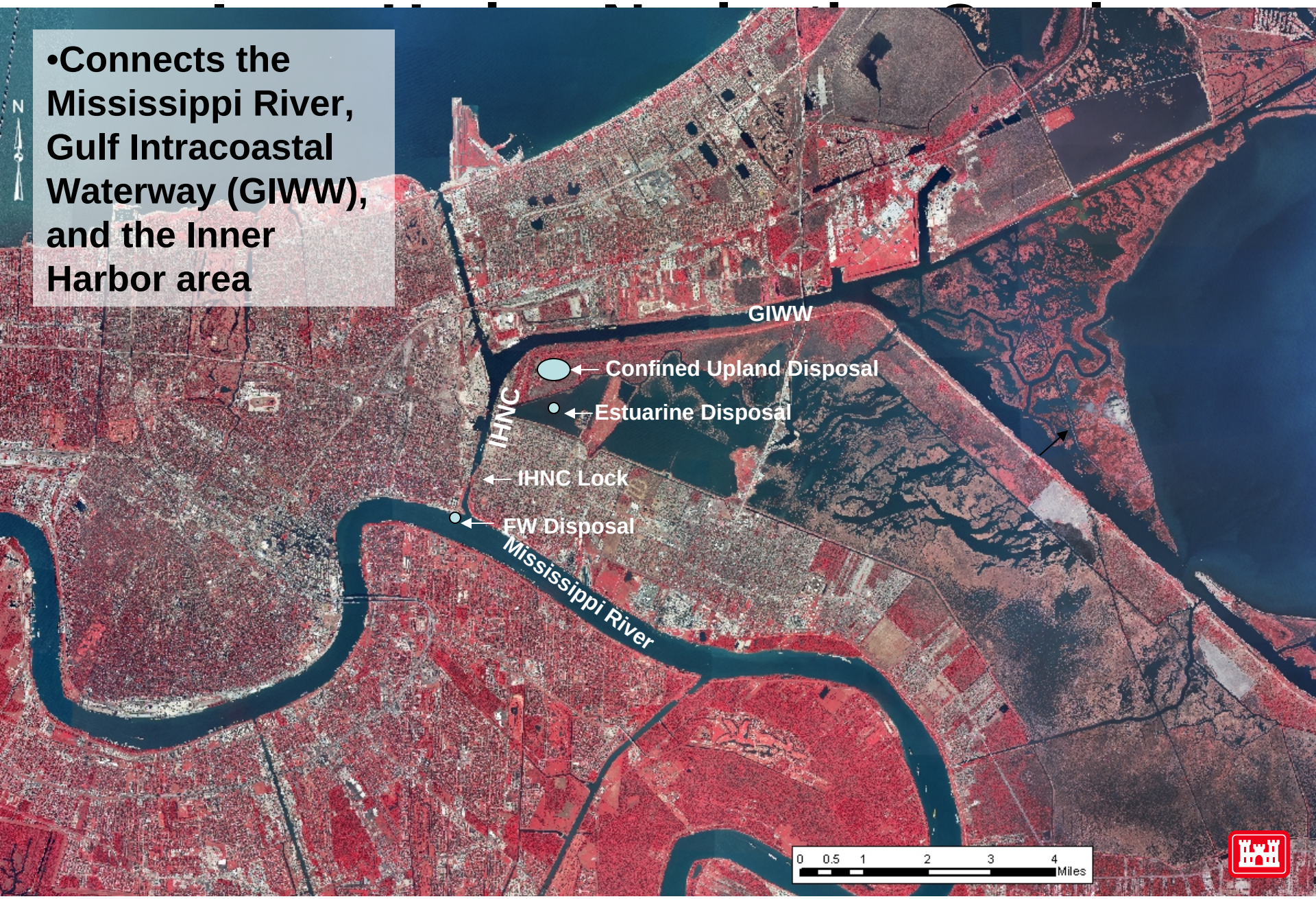
Benthic evaluation

Benthic toxicity

Benthic bioaccumulation

Terrestrial evaluation

Plant and earthworm toxicity and bioaccumulation

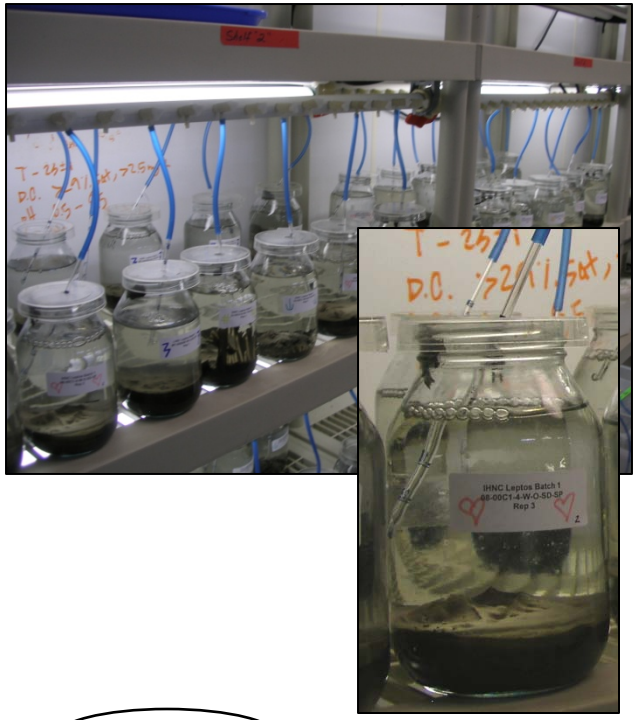

•Connects the Mississippi River, Gulf Intracoastal Waterway (GIWW), and the Inner Harbor area
N
GIWW
Confined Upland Disposal
Estuarine Disposal
IHNC
IHNC Lock
FW Disposal
Mississippi River
0 0.5 1 2 3 4
Miles

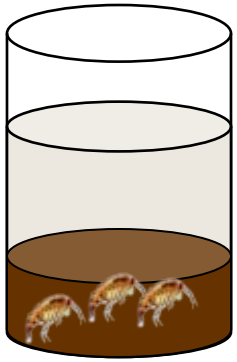
Benthic Evaluation – Benthic Toxicity

- **Conduct 10-day whole-sediment exposure**
- **Survival of organisms as toxicological endpoint**
- **Compare % survival: Dredged Material vs. Reference**

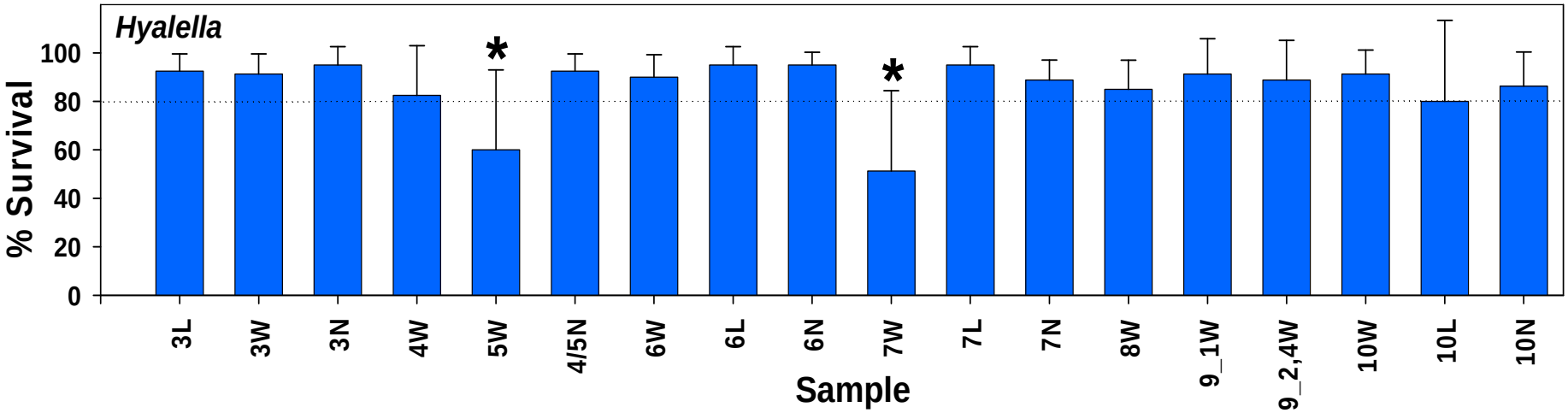
Estuarine species *Leptocheirus plumulosus*

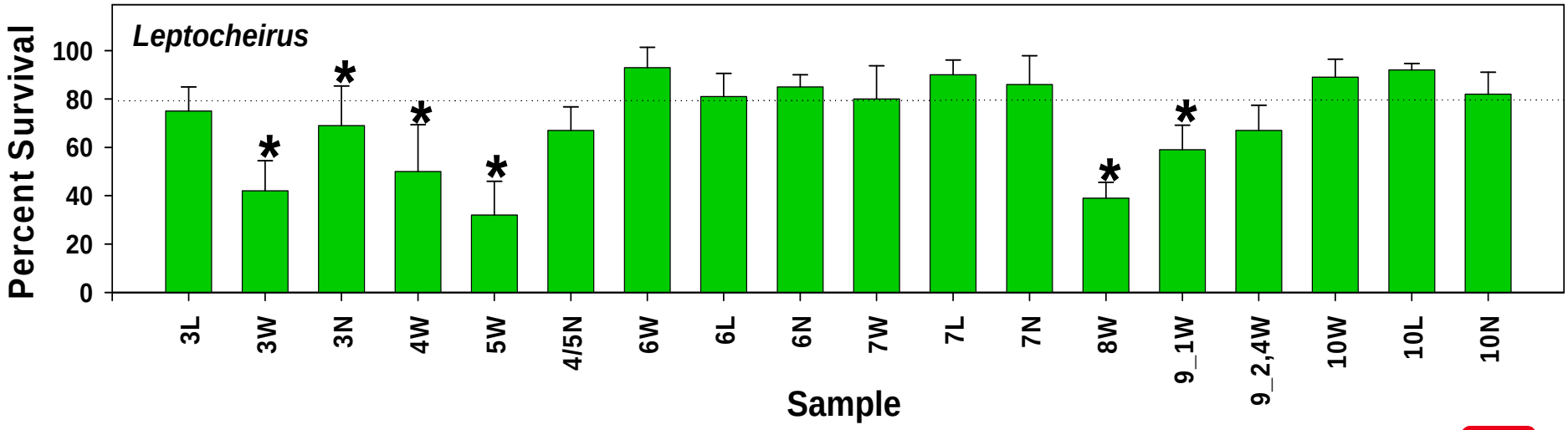
Freshwater species *Hyalella azteca*



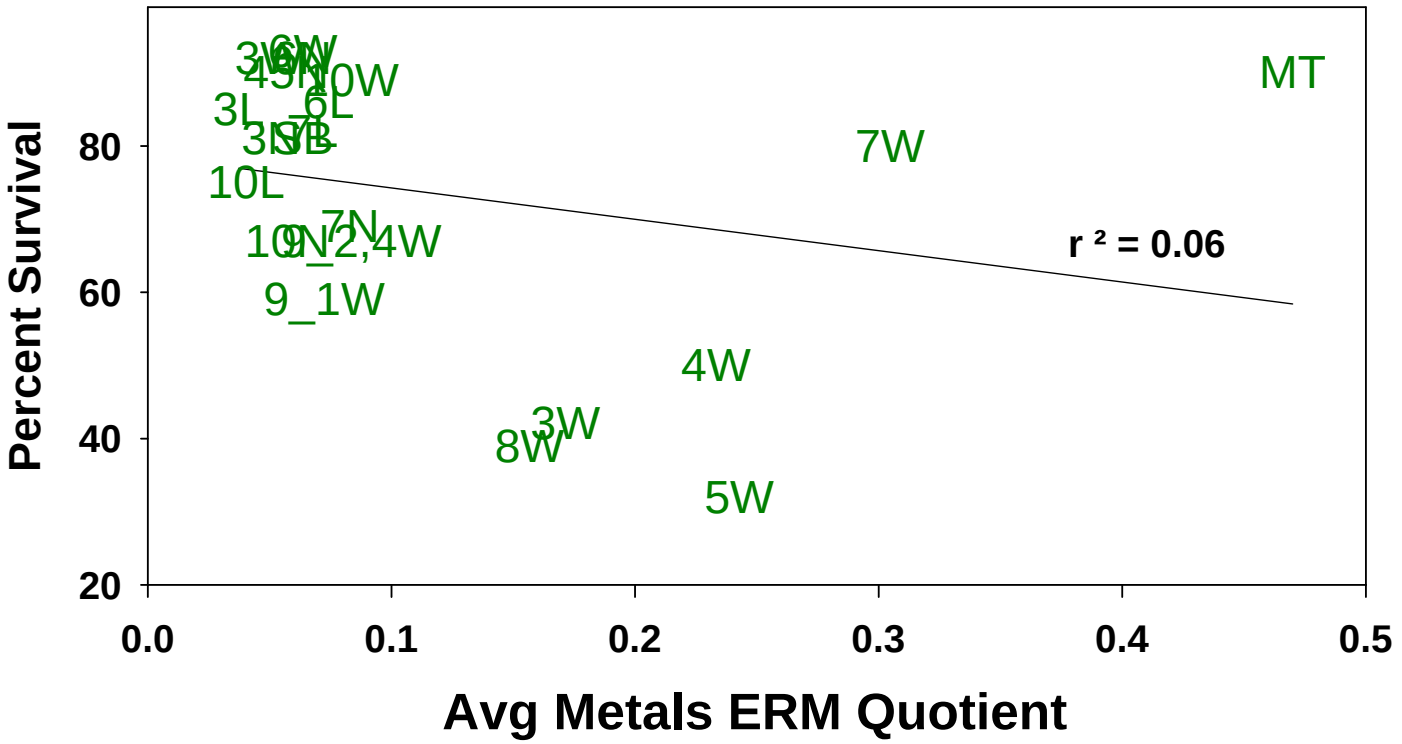


Hyalella and *Leptocheirus* Survival

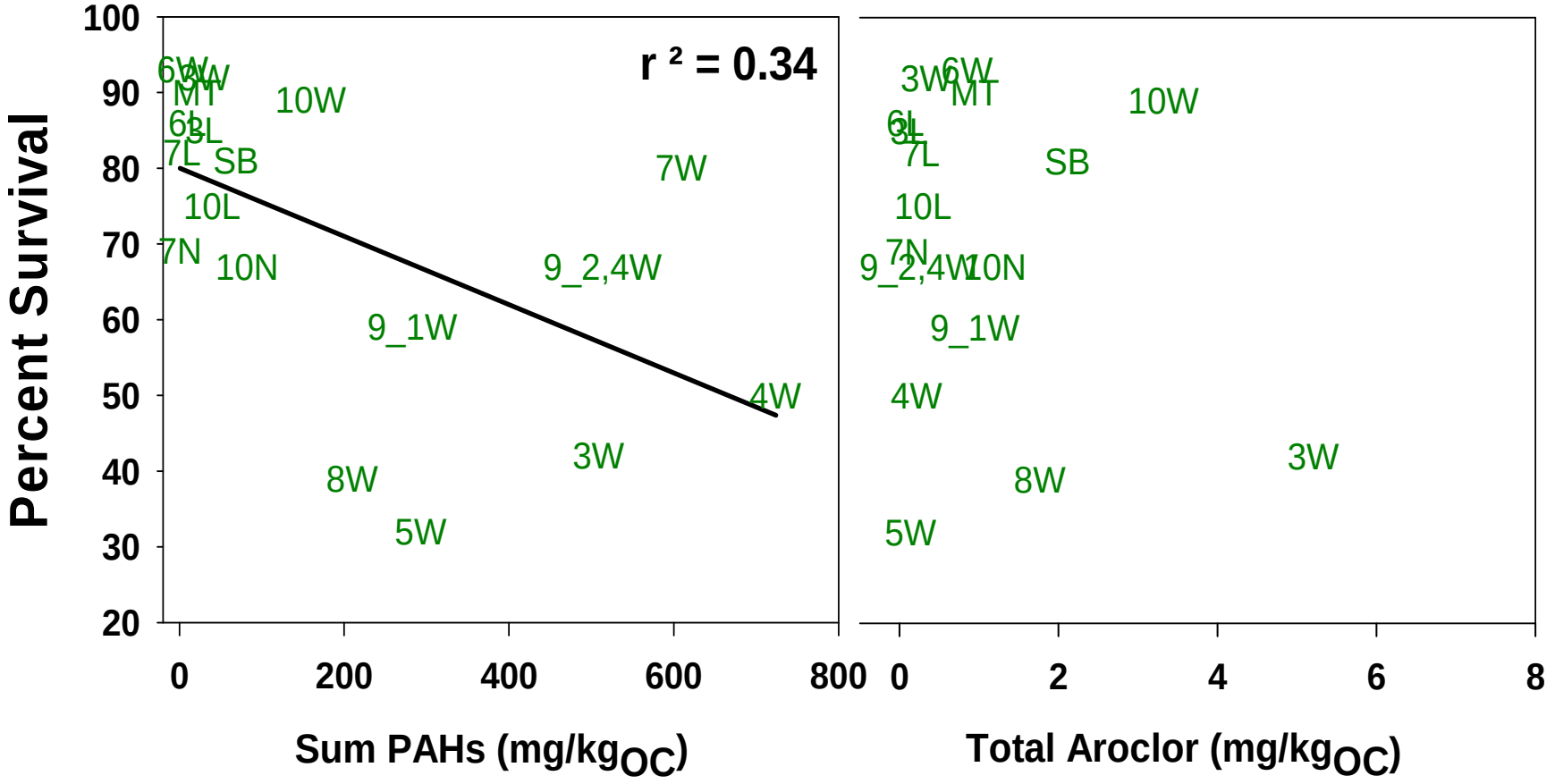




Leptocheirus Survival vs. Sediment Contamination



Leptocheirus Survival vs. Sediment Contamination



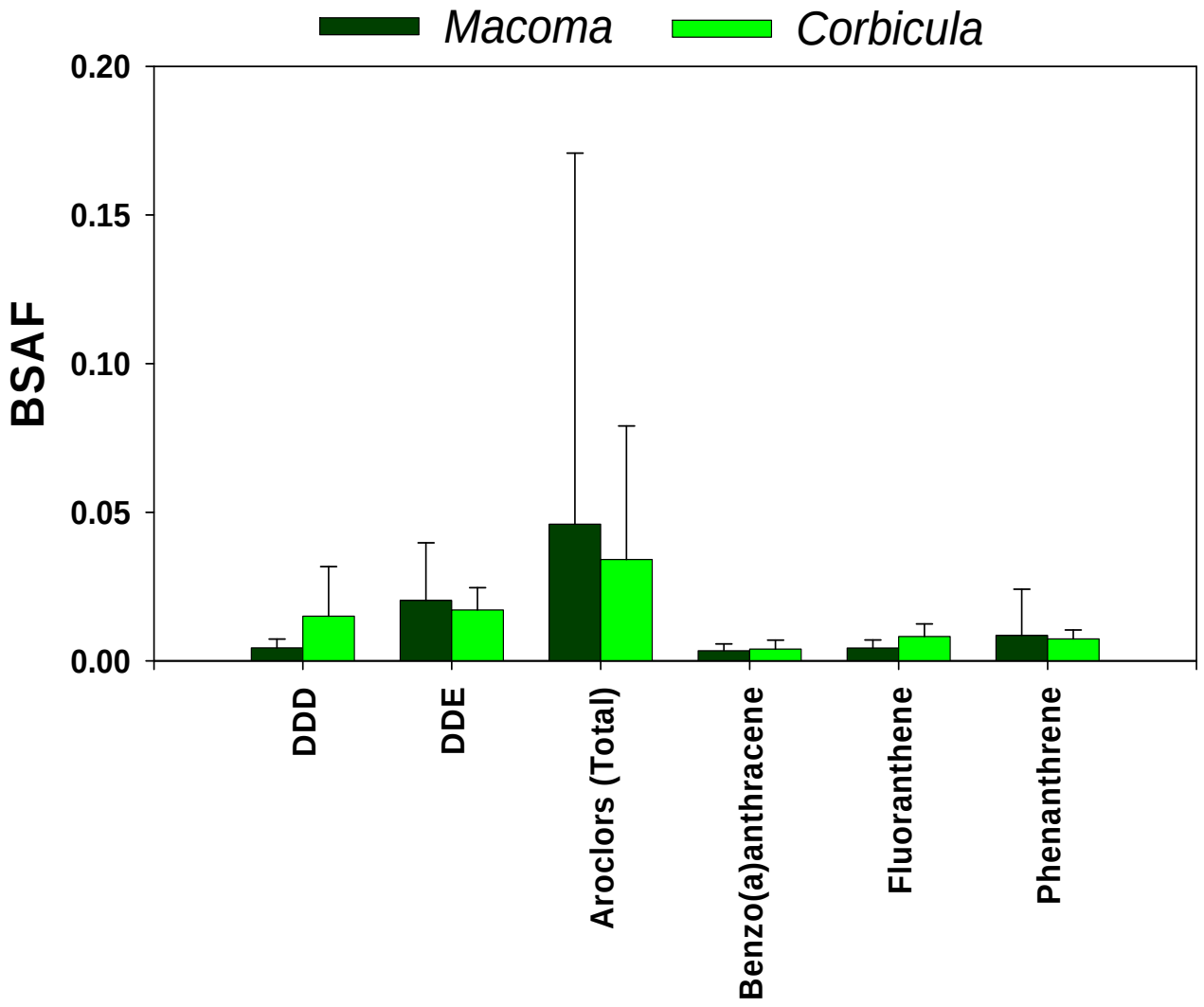
Benthic Bioaccumulation

- **Conduct 28-day whole-sediment exposure**
- **Accumulation of chemicals of interest in organisms as endpoint**
- **Compare tissue concentrations: Dredged Material vs. Reference**

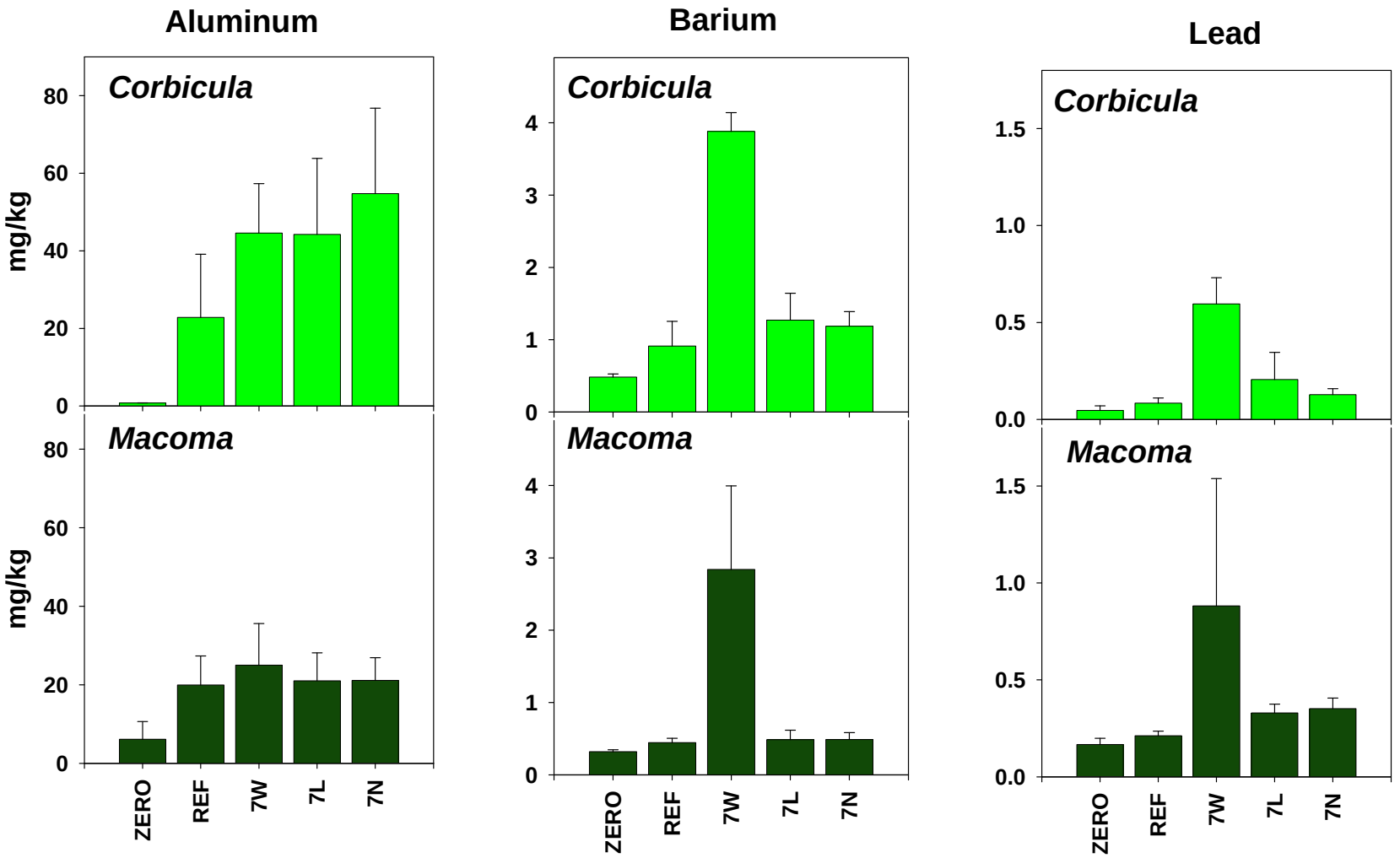
Estuarine Species
Macoma nasuta

Freshwater Species
Corbicula fluminea

Bioaccumulation of Hydrophobic Organics



Bioaccumulation of Metals



Disposal of IHNC Dredged Material

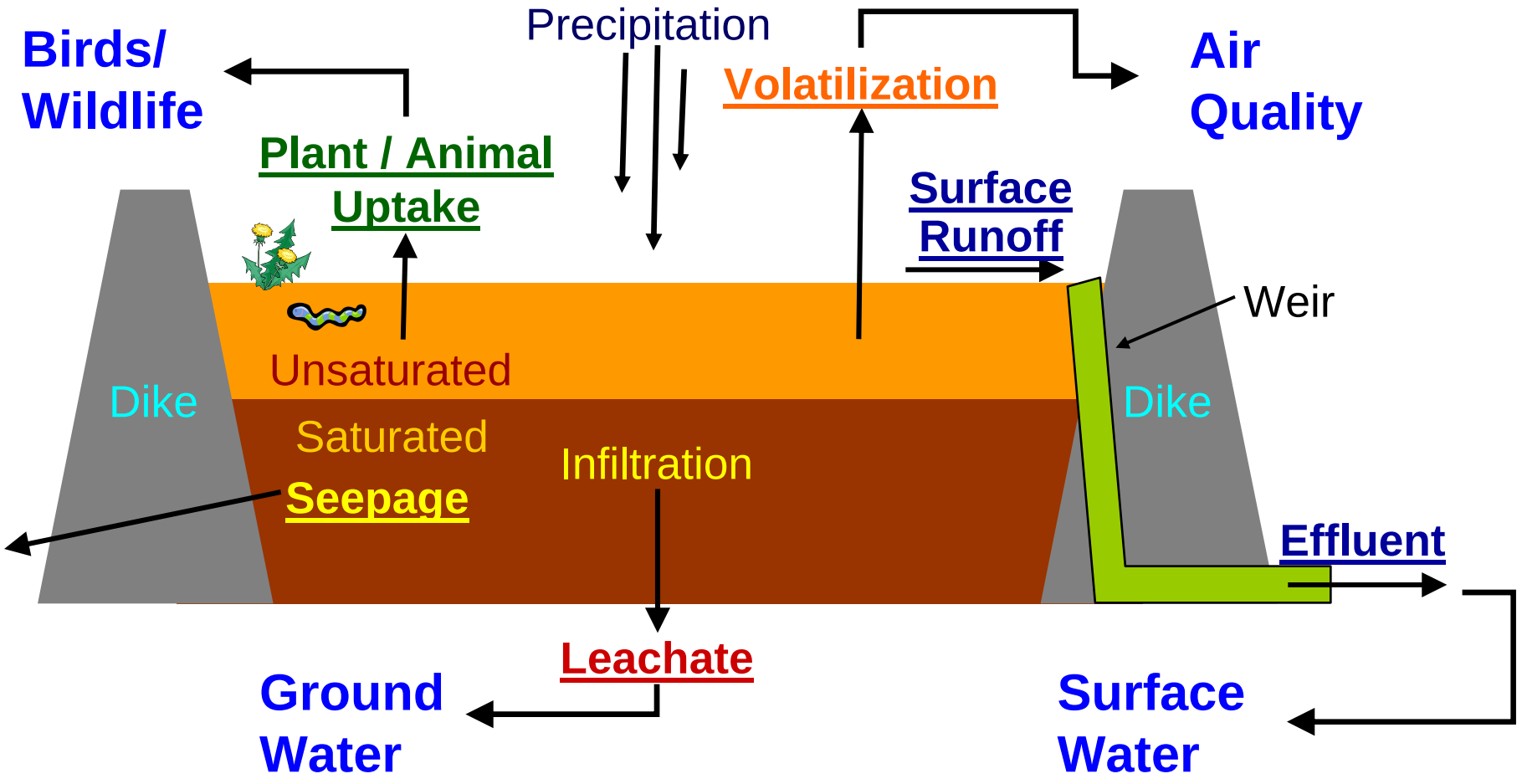
DMMU	Material	Estuarine Disposal		Freshwater Disposal		Disposal Alternative
		Benthic Evaluation	Water Colum Evaluation	Benthic Evaluation	Water Column Evaluation	
1	Surface sediment					CDF - Permanent
2	Surface sediment					CDF - Permanent
3	Top fill from bank					Wetland creation
	Surface sediment					River
	Native subsurface					River
4	Surface sediment					River
5	Surface sediment					CDF - Permanent
4/5	Native subsurface					Wetland creation
6	Surface sediment					CDF - Fill material
	Top fill from bank					CDF - Fill material
	Native subsurface					CDF - Fill material
7	Surface sediment					CDF - Permanent
	Top fill from bank					River
	Native subsurface					Wetland creation
8	Surface sediment					River
9	Surface sediment 1					River
	Surface sediment 2&4					Wetland creation
10	Surface sediment					River
	Top fill from bank					River
	Native subsurface					River


Image © 2008 DigitalGlobe
© 2008 Sanborn
Image © 2008 TerraMetrics
Google
Pointer
Streaming
Eye alt

Upland Disposal Regulated under Clean Water Act

- Regulatory (Section 404)
- Requires return flow
  - Trigger for RCRA Subtitle C Exclusion
- Approximately 260M cy navigation dredging annually
- Approximately 55-60% placed in CDFs
- Approximately 60% hydraulically dredged by cutterhead

Conceptual Model - Contaminant Pathways



Human Health Concerns

- On-site exposure limited
  - On-site workers
  - Visitors to the site
- Off-site exposure evaluated through pathway analysis of primary release pathways
  - Volatilization
  - Particulate transport
  - Surface water and groundwater
  - Addressed with engineering controls
  - Additional analysis
    - Comparison of sediment concentrations to RECAP standards
    - Assess impacts associated with catastrophic release
  - Human health risk assessment underway

Comparison of DMMU Average Sediment COC concentration with RECAP Standards

DMMU 7 dredged material will be the first material placed in the CDF. It will be capped with DMMU 5 dredged material after 1-2 years and DMMUs 1 and 2 dredged material after 6-7 years.

Comparison with Management Option 1 Standards (MO1) non-industrial

- DMMU 7 exceedance for benzo(a)pyrene (ratio = 2.1) and benzo(b)fluoranthene (ratio = 1.4) only.
- DMMU 5: No exceedance of $MO1_{ni}$
- DMMUs 1 and 2: Exceedance for benzo(a)pyrene only (ratios = 1.03 and 1.08, respectively). No exceedances for estimated wet wt. concentrations.

Comparison with Screening Standards (SS) non-industrial

- Above exceedances for PAHs and DMMUs 7, 5, 1 and 2 exceedance for barium (ratio 3.6 or lower).

Upland Evaluation
Biological Evaluation of Exposure Pathways

Animal Bioaccumulation Test

Plant Bioaccumulation Test

Potential Effect on Wildlife

- Plant growth will be controlled until placement of all material
- Slow colonization of soil organisms and upland plants expected
  - Low survival and biomass observed in dredged and reference materials.
- Comparison with Eco-SSLs

Compound	DMMU			
	7	5	1	2
Antimony				
Cadmium				
Chromium				
Copper				
Lead (inorganic)				
Selenium				
Zinc				
Dieldrin				
DDT				
Fluoranthene				
Pyrene				

- Comparison with mammalian and avian TRVs
  - Body residues < Acceptable concentrations (TRV/FIR)
- No need for engineering management likely

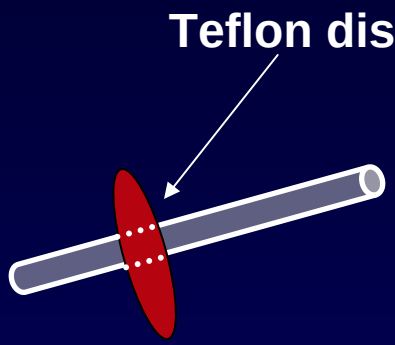
Summary and Conclusions

- **Evaluation of brackish water samples using estuarine, freshwater and terrestrial tests overall successful.**
- **Amphipod mortality: *Hyalella* in 2 samples; *Leptocheirus* in 6 samples – non-contaminant factors likely contributed to mortality.**
- **Exceedingly low bioavailability of PAHs, PCBs and chlorinated pesticides (BSAFs < 0.05). Impacts to higher trophic levels unlikely.**
- **Exceedance of water quality criteria excluded dredged material non-toxic to benthos or larval fish from marsh creation beneficial use.**
- **Extreme concern and opposition from neighboring residential communities and caution from state agency prompting formal human heath risk assessment and application for waiver from solids waste regulation of dredged material proposed fro upland placement.**

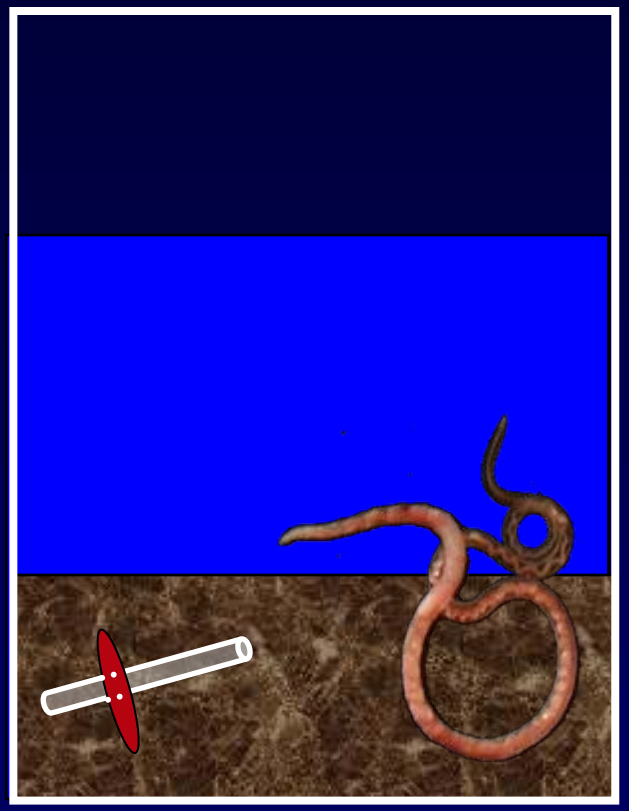
Sediment Bioavailability and Bioaccumulation Research at ERDC

- **PCBs bioaccumulation in *Nereis virens* – Approach to determine steady-state body residue**
- **Use of passive samplers in dredged material bioaccumulation laboratory evaluation and *in situ***
- **Method development and comparative exposure experiments towards using *Leptocheirus* as bioaccumulation test organism.**
- **Use of amendments to reduce bioavailability of sediment-associated contaminants**

SPME Deployment in Sediment Lab Exposures



Stainless steel mesh envelope

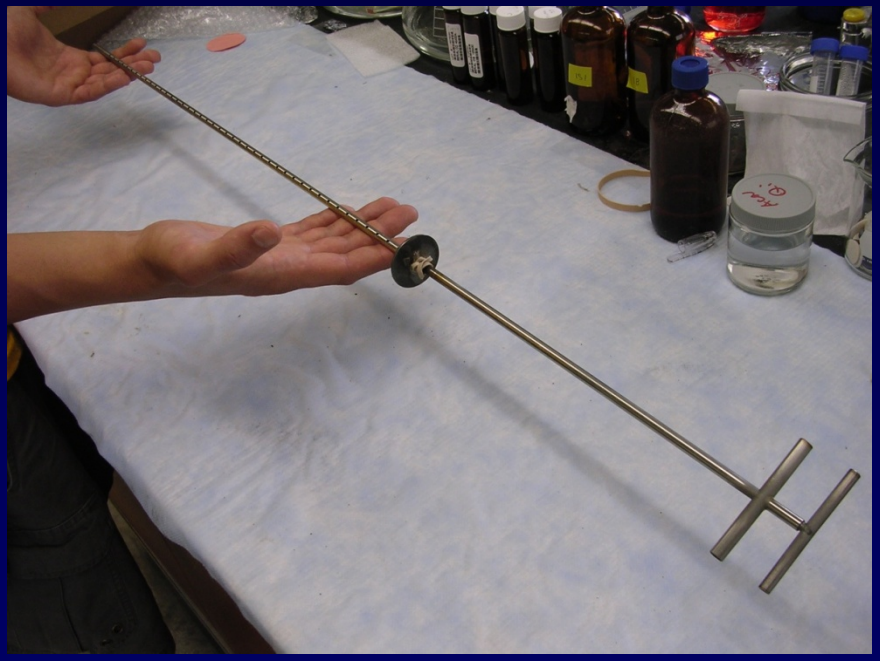


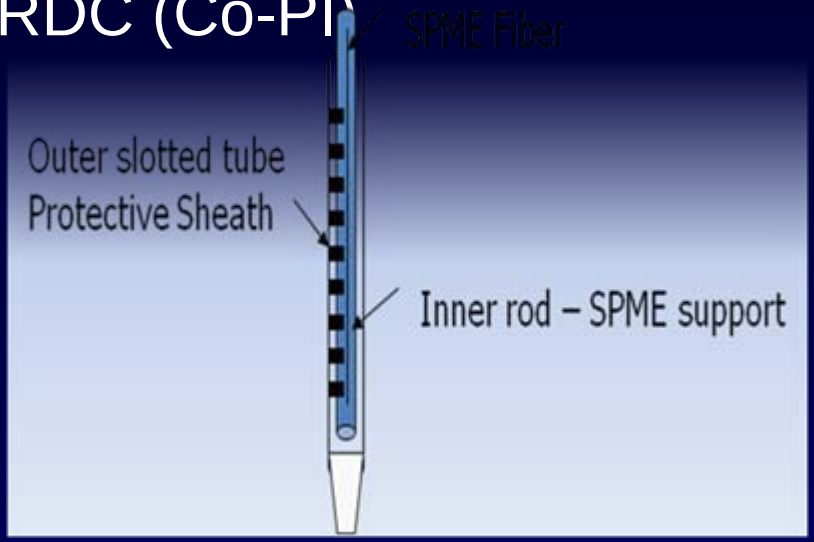
Invertebrate bioaccumulation test beaker

Conder et al. (2003): *Env. Sci. Technol.* 37:1625
Conder and La Point (2004): *Env. Tox. Chem.* 23:141

Field Deployment of SPMEs

ESTCP Project. D. Reible, University of Texas (PI)
G. Lotufo, ERDC (Co-PI)





Field Deployment of SPMEs

Anacostia River

Shallow river bed
Employed divers

Hunters Point

Intertidal area
Easy deployment

Laboratory Experiment
New Bedford Harbor Dilution Series

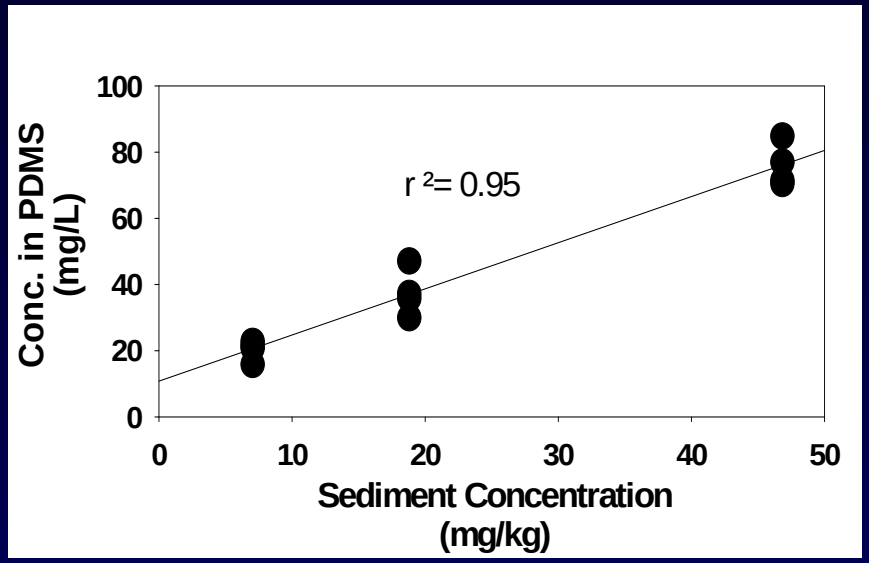
Comparison of *Leptocheirus* and *Macoma*

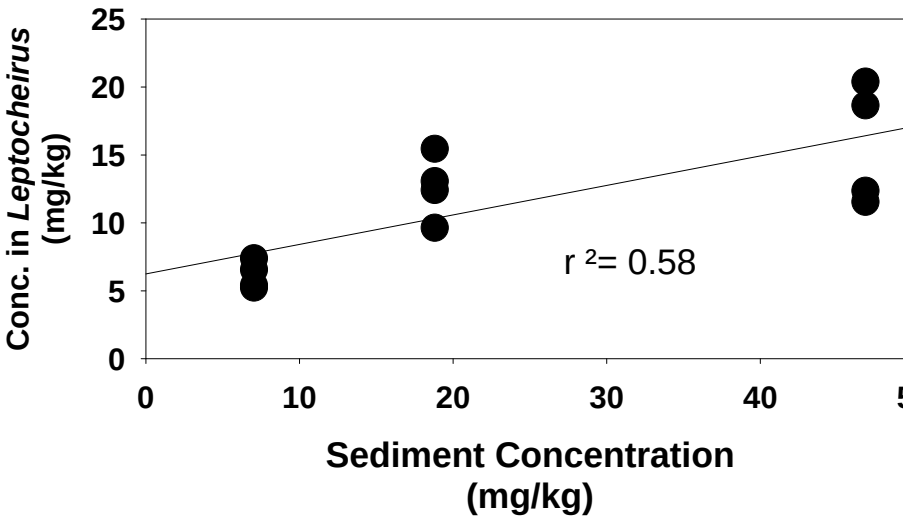
- 12, 6, and 3% dilutions
- 28-day exposure duration
- No feeding for *Macoma*, feeding for *Leptocheirus*
- SPMEs placed in *Leptocheirus* beakers only

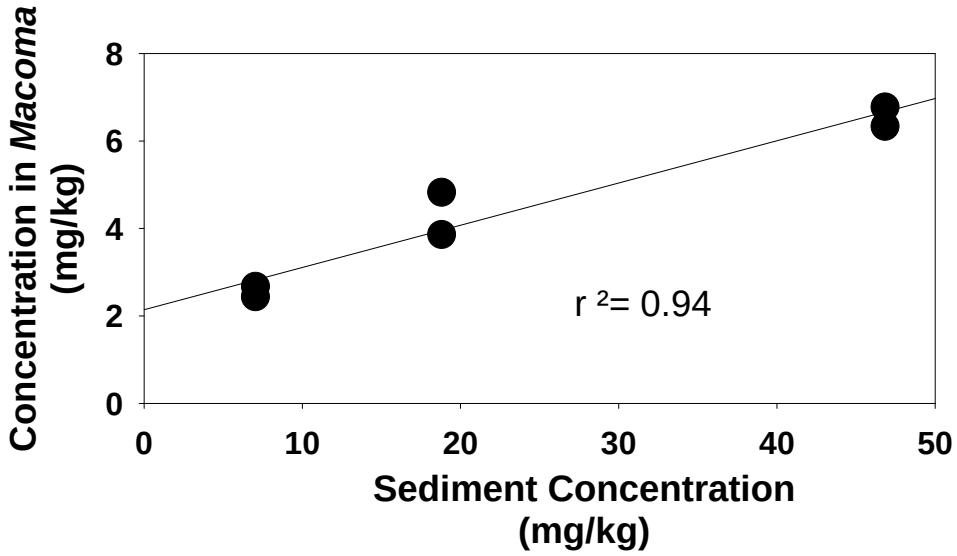
Macoma nasuta

Leptocheirus plumulosus

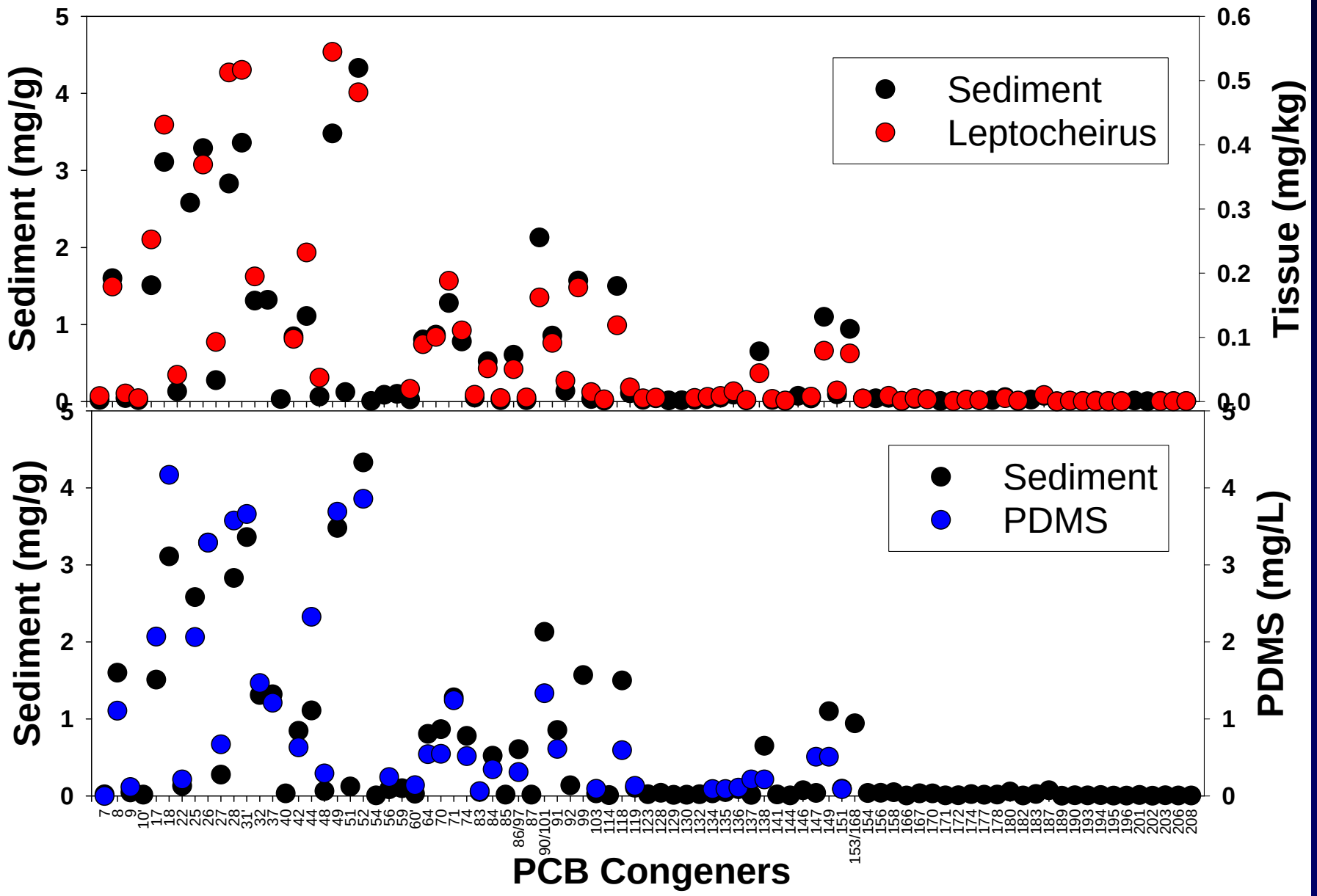
PDMS and Body Residues vs Sediment Concentratio





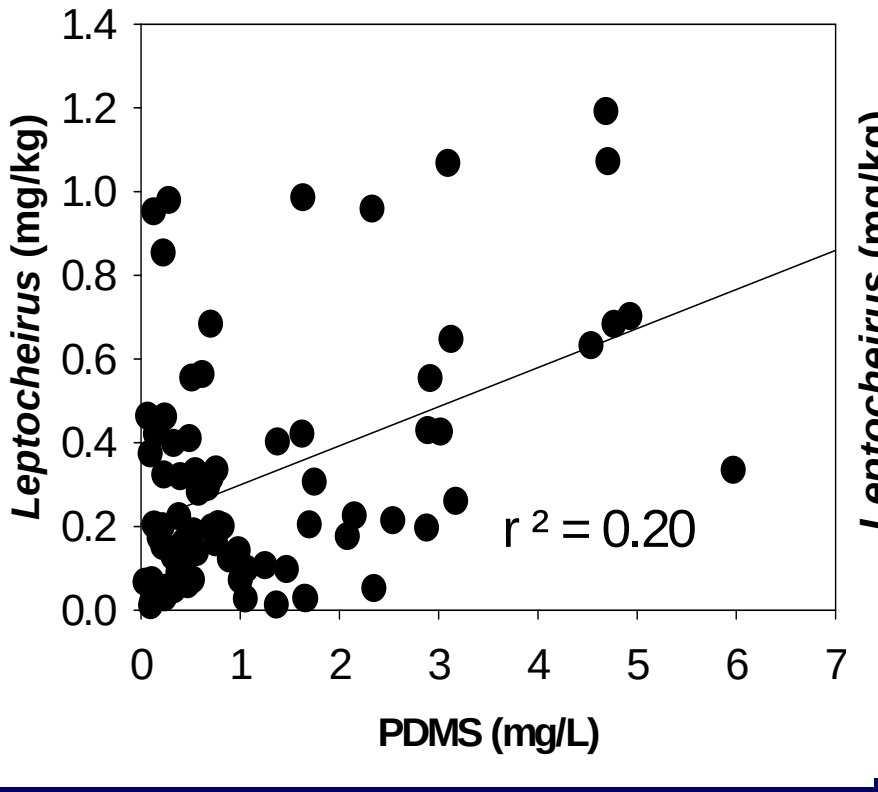


Sediment, PDMS and Tissue Concentrations

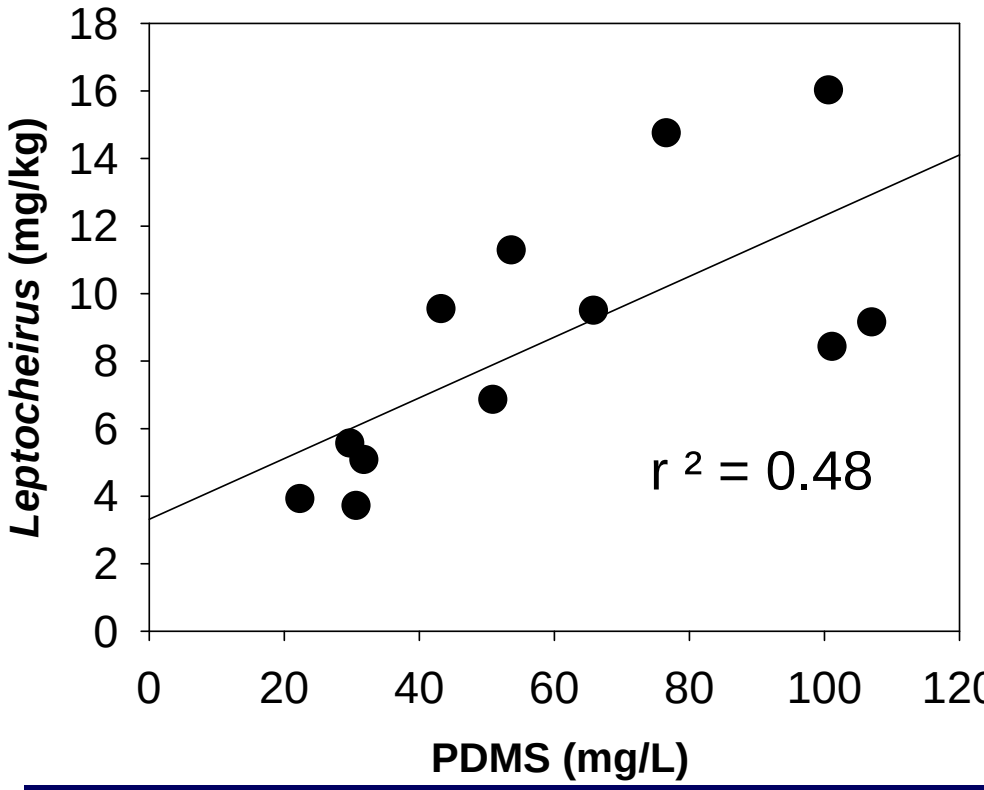


Relationship between PDMS and Tissue Concentrations

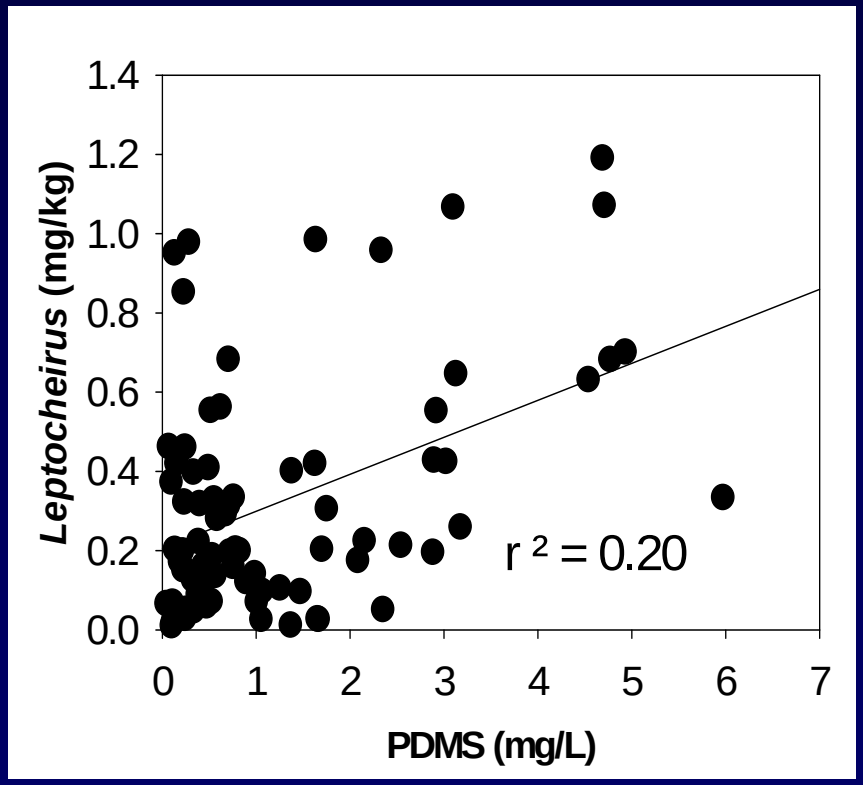
Individual PCB Congeners

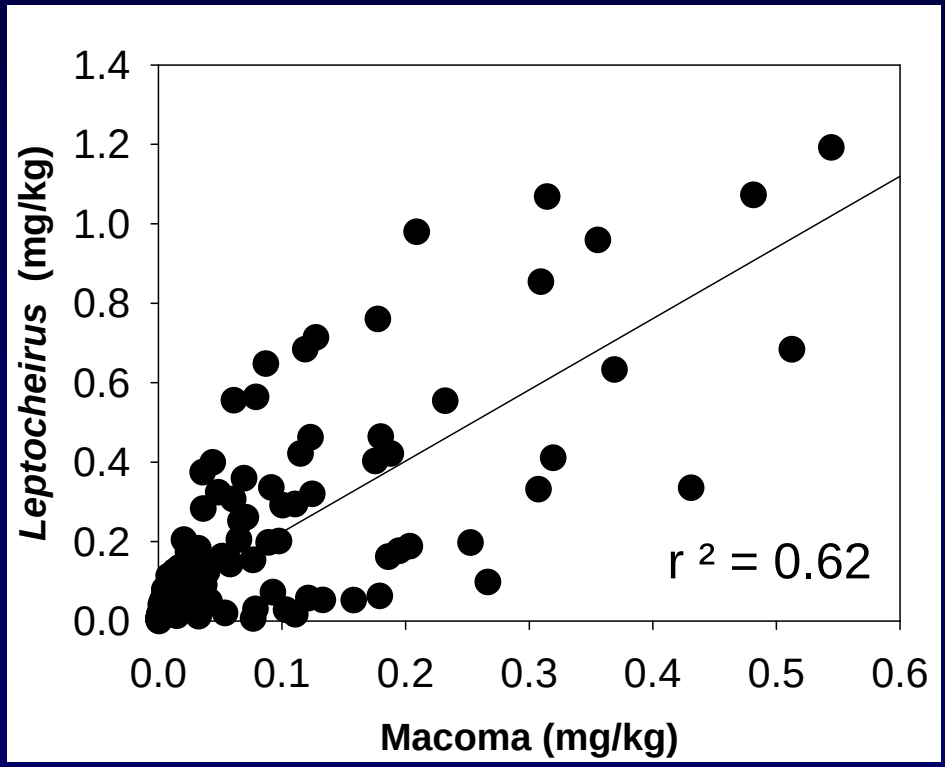


Sum PCBs

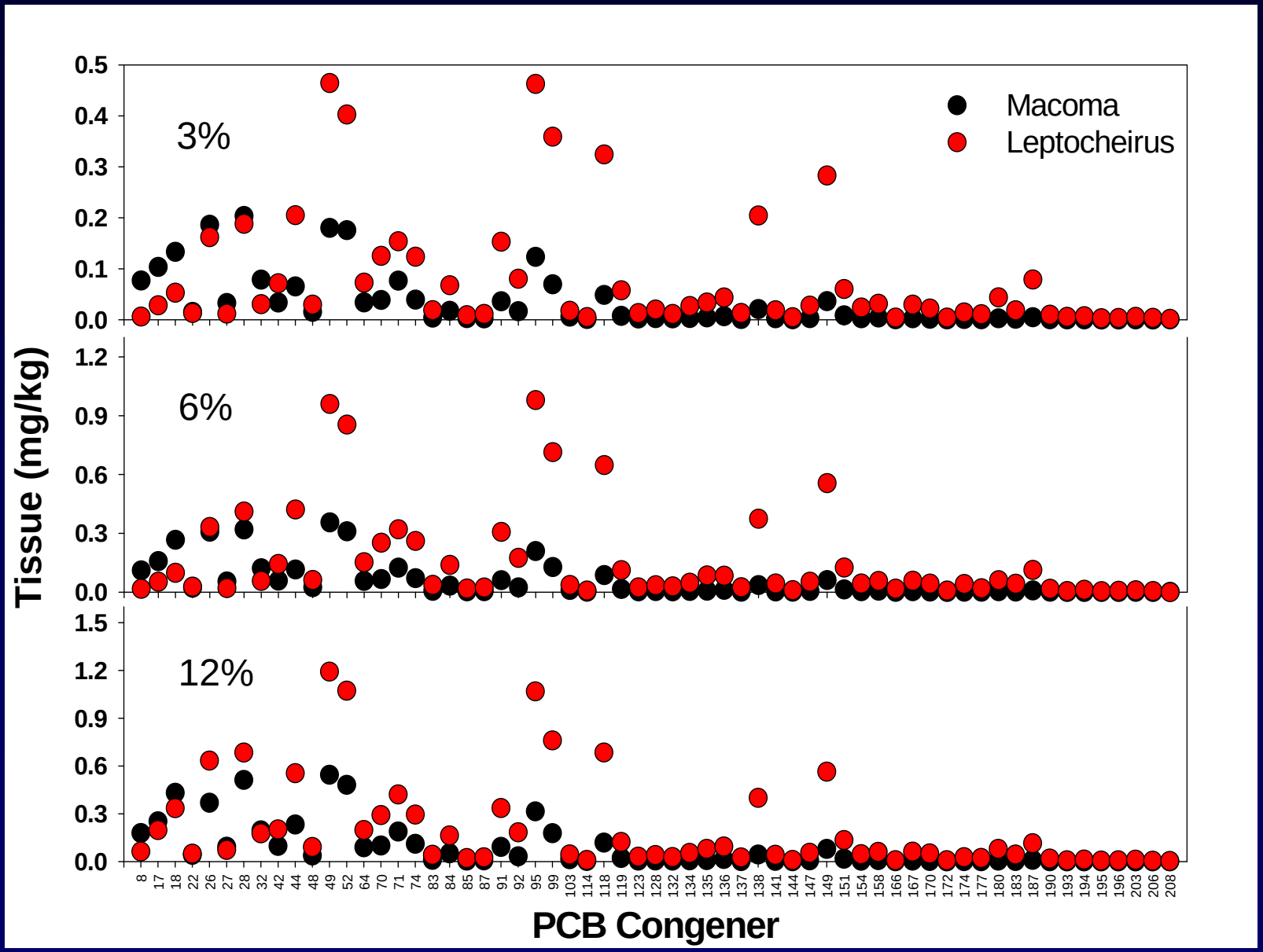


Predicting *Leptocheirus* Body Residues: PDMS vs *Macoma*





Leptocheirus vs *Macoma* Body Residues



Leptocheirus vs *Macoma* Body Residues